

REMARKS

Claims 1, 3 through 9, 11, 12 and new Claims 13 through 15 are pending in the application.

Claim 1 been amended to reflect advantageous embodiments in which the solvation delay ranges from a few seconds to a plurality of hours. Support for this amendment can be found in the Application as-filed, for example on Page 2, lines 13 through 14.

Claim 1 has also been amended to reflect that the recited solvation delay provides an open time upon stirring the reversibly crosslinked cellulose ether into the aqueous solution. Support for this amendment can be found in the Application as-filed, for example on Page 2, lines 14 through 17.

Claim 1 has been further amended to reflect advantageous embodiments in which the amount of chemical compound containing at least one aldehyde group and at least one acid group is in the range from 0.01 to 0.1 mol per mole of cellulose ether. Support for this amendment can be found in the Application as-filed, for example in Claim 5 as-filed.

Claim 5 has been canceled, as its subject matter has been incorporated into Claim 1.

Claims 13 through 15 have been added to complete the record for examination and highlight advantageous embodiments of the invention.

Claim 13 been amended to reflect advantageous embodiments in which the solvation delay is 4.5 minutes up to a plurality of hours. Support for Claim 13 can be found in the Application as-filed, for example on Page 7, line 16 through 25 and Page 2, lines 13 through 14.

Claim 14 reflects advantageous methods comprising initially forming a cellulose ether composition by admixing cellulose ethers in water; comminuting the admixed cellulose ether composition; milling the comminuted cellulose ether composition and drying the milled cellulose ether composition to form an ester or hemiacetal bond. Support for Claim 14 can be found in the Application as-filed, for example on Page 7, lines 16 through 27.

Claim 15 reflects advantageous methods comprising initially admixing a cellulose ether composition in an organic suspension medium with chemical compounds containing at least one aldehyde group and at least one acid group; filtering the admixed cellulose ether composition; drying the filtered cellulose ether composition; comminuting the filtered cellulose ether composition; and heating the comminuted cellulose ether composition to form an ester or hemiacetal bond at a temperature ranging from 50 to 105 °C. Support for Claim 15 can be found in the Application as-filed, for example on Page 7, line 27 through Page 8, line 9 and Page 5, lines 17 through 19.

Applicants respectfully submit that this response does not raise new issues, but merely places the above-referenced application either in condition for allowance, or alternatively, in better form for appeal. Reexamination and reconsideration of this application, withdrawal of all rejections, and formal notification of the allowability of the pending claims are earnestly solicited in light of the remarks which follow.

Section 112 Rejection

Claim 1 stands further rejected over the term “solvation delay.” Applicants respectfully reiterate that “solvation delay” is a term that is well understood to one skilled in the art. Nevertheless, without further addressing the merits of the rejection and solely to advance prosecution of the above-referenced case, Claim 1 has been amended to recite a defined solvation delay of a few seconds up to a plurality of hours. Accordingly, Applicants respectfully request withdrawal of the foregoing rejection.

The Claimed Invention is Patentable in Light of the Art of Record

Claims 1, 3 through 9, 11 and 12 stand rejected over United States Patent No. 3,072,635 to Menkart¹ et al in light of European Patent Application 0 252 649 A2 to Herron et al.

It may be useful to briefly consider the invention before addressing the merits of the rejection.

The production of aqueous solutions of cellulose ethers can be problematic. This applies, in particular, when the cellulose ether is present as fine powder having enlarged surface area. If such a cellulose ether powder comes into contact with water, the individual granules swell and clump together to form relatively large agglomerates, the surface of which is thickened in a gel-like manner. However, depending on the mixing intensity, a certain proportion of completely unwetted cellulose ether is situated in the interior of these agglomerates. Complete dissolution of these agglomerates can take up to 24 hours. Crosslinking of cellulose can be beneficial in the dissolution of cellulose ethers, for example by controlling swelling.

Glyoxal has heretofore been known for use in crosslinking cellulose ethers, as clearly evidenced by Menkart. Carbaldehyde groups on the glyoxal react with the hydroxy groups of the cellulose ether to form hemiacetal bonds. Hemiacetal bonds are pH sensitive, and cleave when the cross-linked cellulose ether is stirred into neutral or weakly acidic water, as discussed in the Application-as-filed on Page 2, lines 26 through 30, and as further correctly noted by the Examiner. Such cleavage is problematic because it reintroduces the glyoxal back into solution. Glyoxal, as well as a number of other low-molecular weight cross-linkers, pose a potential health risk. Glyoxal has in recent years been categorized as a mutagen and sensitizing substance, for example.

¹ Applicants Representative respectfully reiterates that United States Patent 3,072,635 ("US 635") indicates on its face that Menkart is the primary inventor, rather than Meukart as indicated in the outstanding Office Action. Accordingly, remarks noting Menkart are intended to distinguish US 635.

The challenges associated with the crosslinking of cellulose ethers are further exacerbated by large-scale manufacturing issues. It is problematic to disperse crosslinker within cellulose ether, for example, as evidenced by Menkart at Col. 3, lines 4 through 6. Menkart addresses the issue through unconventional methods, such as vapor treatments and the like.

It was thus an object of the present invention to develop a method by which cellulose ethers can be reversibly crosslinked and which succeeds without the use of low molecular weight compounds, such as glyoxal, which are set free again when using the crosslinked cellulose ethers, and which further can be used in large-scale industrial production of uniformly crosslinked cellulose ethers. In addition, such methods should not substantially interfere with the beneficial rheology provided by cellulose ethers.

Applicants have found that the use of a mixed functionality cross-linker allows the production of cellulose ether solutions which are readily stirrable and provides a defined solvation delay, without producing small molecules in solution.

Applicants have more particularly determined that reversible cross-linking compounds that further include an acid group produce an ester upon reacting with a hydroxy group on the cellulose ether. The formation of such an ester group was quite surprising to those skilled in the art because the hydroxy group on cellulose ether is not considered readily accessible for cross-linking agents containing carboxy groups.

This ester group is highly beneficial because it remains intact when the cross-linked product is brought into contact with water, as discussed in the Application-as-filed on Page 4, lines 9 through 14. Accordingly, no cross-linking agent (e.g. no low molecular weight compound) is released when the cross-linked cellulose ether is dissolved in water, thereby avoiding a possible health risk. Altogether unexpectedly, the ester bonded molecule remaining on the reacted cellulose does not interfere with the rheology of the resulting cellulose ether solution.

Accordingly, the claims are directed to methods for producing reversibly crosslinked cellulose ethers comprising initially admixing a cellulose ether composition comprising cellulose ethers having free OH groups in water or in an organic suspension medium with chemical compounds containing at least one aldehyde group and at least one acid group, with the cellulose ether not being dissolved in the water or the suspension medium.

In advantageous embodiments, the chemical compound containing at least one aldehyde group and at least one acid group is present in an amount ranging from 0.01 to 0.1 mol per mole of cellulose ether and imparts a solvation delay to the resulting temporarily-crosslinked cellulose ether of a few seconds to a plurality of hours, as recited in Claim 1 as-amended.

In particularly beneficial aspects, the recited amount of chemical compound containing at least one aldehyde group and at least one acid group imparts a solvation delay to the temporarily-crosslinked cellulose ether of at least 4.5 minutes, as reflected in newly added Claim 13.

In particularly advantageous embodiments, the un-dissolved cellulose ether is moistened with 10 to 80 % water, based on the amount of cellulose ether, or suspended in 30 to 60% organic suspension medium, based on the amount of cellulose ether, as recited in Claim 11.

Further advantageous aqueous-based methods comprise initially forming a cellulose ether composition by admixing cellulose ethers in water; comminuting the admixed cellulose ether composition; milling the comminuted cellulose ether composition and drying the comminuted and optionally milled cellulose ether composition to form an ester or hemiacetal bond, as recited in newly added Claim 14.

Additional advantageous organic-suspension methods comprise initially admixing a cellulose ether composition in an organic suspension medium with chemical compounds

containing at least one aldehyde group and at least one acid group; filtering the admixed cellulose ether composition; drying the filtered cellulose ether composition; comminuting the filtered cellulose ether composition; and heating the comminuted cellulose ether composition to react the acid groups and aldehyde groups of the chemical compounds with the OH groups of the cellulose ethers to form an ester bond or hemiacetal bond at a temperature ranging from 50 to 105 °C, as recited in newly added Claim 15.

Applicants respectfully reiterate that the cited references do not teach or suggest the claimed invention, considered either alone or in combination.

Menkart is merely directed to the conventional use of aldehyde treating agents. (Col. 1, lines 45 – 50). Menkart generally indicates that any of glyoxal, formaldehyde or succinaldehyde may be reacted with cellulose ethers, with glyoxal being preferred. (Col. 1, lines 48 – 50). Menkart teaches that moisture is important for good contact with the treating agent. (Col. 3, lines 4 – 6). Menkart expressly teaches the use of dilute cellulose ether solutions, such as a 10 % cellulose ether solution in alcohol. (Col. 5, lines 55 – Col. 6, line 4). Menkart alternatively disclose the combination of glyoxal with the cellulose ether by vapor treatment or the like. (Col. 3, lines 49 – 63). Menkart repeatedly discloses the direct crosslinking of cellulose ether filter cake during a single-step drying. (Col. 3, lines 38 – 43; Ex. 1, Col. 5, line 55 – 67 and Exs. 6 and 7, Col. 7, lines 19 – 42) In contrast to the urgings of the outstanding Office Action on Page 5, Menkart is not directed to the crosslinking of cellulose.

Applicants respectfully reiterate that Menkart does not teach or suggest the claimed invention.

Menkart, altogether silent as to agents other than its aldehyde treating agents, does not teach or suggest the inventive methods for producing reversibly-crosslinked cellulose ethers in which cellulose ethers having free OH groups are admixed with chemical compounds containing at least one acid group. Nor would there have been any motivation for Menkart to have

incorporated the recited chemical compounds containing at least one acid group, as there would have been no expectation of success.

Nor does Menkart, teaching the reaction of a dilute cellulose solution, teach or suggest the recited methods in which the cellulose ether is admixed but not dissolved in the water or the organic suspension medium prior to reaction.

And Menkart, altogether silent as to solvation delay, most certainly does not teach or suggest that cellulose ether containing from 0.01 to 0.1 mol per mole of a chemical compound containing at least one aldehyde group and at least one acid group would result in reversibly-crosslinked cellulose ether having a solvation delay of a few seconds to a plurality of hours, as recited in Claim 1 as-amended.

Thus Menkart can not teach or suggest that cellulose ether containing from 0.01 to 0.1 mol per mole of a chemical compound containing at least one aldehyde group and at least one acid group would result in reversibly-crosslinked cellulose ether having a solvation delay of at least 4.5 minutes, as reflected in newly added Claim 13.

Menkart further fails to teach or suggest advantageous methods in which the cellulose ether is moistened with 10 to 80 % water, based on the amount of cellulose ether, or suspended in 30 to 60% organic suspension medium, based on the amount of cellulose ether, as recited in Claim 11. Menkart instead expressly teaches admixing a dilute solution, followed by solid "separation." (Col. 3, lines 38 – 40).

And Menkart, expressly teaching on numerous occasions the cross-linking of filter cake, further fails to teach or suggest the steps of comminuting an admixed cellulose ether composition; milling the comminuted cellulose ether composition; and drying the milled cellulose ether composition to form an ester bond or hemiacetal bond, as recited in newly added Claim 14.

Menkart, expressly teaching both the crosslinking of filter cake and a single drying step, similarly fails to teach or suggest methods comprising initially admixing a cellulose ether composition in an organic suspension medium with chemical compounds containing at least one aldehyde group and at least one acid group; filtering the admixed cellulose ether composition; drying the filtered cellulose ether composition; comminuting the filtered cellulose ether composition; and heating the comminuted cellulose ether composition to react the acid groups and aldehyde groups of the chemical compounds at a temperature ranging from 50 to 105 °C, as recited in newly added Claim 15.

Accordingly, Applicants respectfully submit that the presently claimed method is patentable in light of Menkart, considered either alone or in combination with the remaining art of record.

Applicants respectfully submit that the claimed invention is likewise patentable in light of Herron.

In contrast to the inventive reversibly cross-linked pulverulent cellulose ethers, Herron discloses a method for purportedly permanently crosslinking cellulose fibers. (Page 3, line 37). In this method intra-fiber crosslinking is achieved, but not an inter-fiber crosslinking. Herron initially notes that formaldehyde crosslinkers cause skin irritation. (Page 3, lines 15 – 16). In contrast to the urgings of the outstanding Office Action on Page 5, last partial paragraph, Herron merely broadly recommends any of a generic list of alternative aldehyde cross-linking agents. (Page 3, lines 44 – 46). Herron ultimately prefers glutaraldehyde, however, as it is said to provide “the most stable crosslink bonds.” (Page 4, lines 29 – 32, also see Page 10, lines 17 – 18 and Page 15, lines 36 - 42). Herron goes on to expressly teach that his crosslinkers form hemiacetal and acetal bonds, with the acetal bonds selected as “the desired bond types” that further provide “stable crosslink bonds.” (Page 4, lines 54 – 56). Herron notes that the fibers may be dried to as little as 0 % moisture content prior to being contacted with the crosslinking

solution. (Page 8, lines 35 – 36). Herron further expressly teaches curing at temperatures of up to 150 °C. (Page 7, lines 3 – 5). Herron's only Working Example is directed to an aqueous fiber "slurry" that is subjected to two separate de-watering steps prior to curing at 145 °C. (Page 15, lines 5 – 19).

Applicants respectfully reiterate that Herron, directed to permanently crosslinked cellulose, does not teach or suggest the recited cellulose ethers, much less reversibly crosslinked cellulose ethers.

Applicants respectfully submit that the crosslinking of cellulose ethers is not comparable to the crosslinking of cellulose, in contrast to the implied assertions within the outstanding Office Action. In that regard, Applicants respectfully submit that cellulose ethers are significantly less reactive than cellulose. Applicants respectfully reiterate that the recited cellulose ethers have a much smaller number (less than half) of the free hydroxy groups which could take part in a crosslinking reaction (the other hydroxy groups are etherified and hence no longer reactive), thus there would have been no motivation to have applied any of Herron's teachings to cellulose ethers.

More specifically, cellulose ethers have a smaller number of free hydroxy groups which can take part in a cross-linking reaction in comparison to cellulose. The cellulose ethers contemplated in the present invention have a molar degree of substitution of about 1.7 to 2.2, which means that from the 3 hydroxy groups present in each anhydroglucose unit on average about 2 are etherified and thus cannot react with cross-linking agents. Furthermore, not all hydroxy groups in the anhydroglucose unit show the same reactivity. More reactive are those in the 2- and 6- position. The hydroxyl group in the 3-position is much less reactive. In a cellulose ether having an average molar degree of substitution of about 2, the hydroxyl groups in the 2- and 6-position are etherified and thus already blocked and only the hydroxyl group in the 3 position is still available. But this hydroxy group is not readily accessible for cross-linking agents.

Applicants respectfully submit that it was quite surprising to one skilled in the art that cellulose ether's hydroxy group in the 3-position was even accessible for a crosslinking agent having carboxy groups. Thus there would have been no expectation of success in applying Herron's teaching to Menkart, in contrast to the urgings of the outstanding Office Action on Page 4, last full paragraph and Page 5, first full paragraph.

Consequently, there would have been no motivation to have formed the recited crosslinked cellulose ethers in light of Herron, and most certainly not such crosslinked cellulose ethers including reversible crosslinked bonds.

Applicants respectfully make of record that, in contrast to the opinion urged within the Office Action on Page 5, last partial paragraph, Herron does not teach glyoxylic acid as a "preferred" crosslinking agent.

And Herron, altogether silent as to solvation delay, most certainly does not teach or suggest that cellulose ether containing from 0.01 to 0.1 mol per mole of a chemical compound containing at least one aldehyde group and at least one acid group would result in reversibly-crosslinked cellulose ether having a solvation delay of a few seconds up to a plurality of hours, as recited in Claim 1 as-amended.

Thus Herron can not teach or suggest that cellulose ether containing from 0.01 to 0.1 mol per mole of a chemical compound containing at least one aldehyde group and at least one acid group would result in reversibly-crosslinked cellulose ether having a solvation delay of at least 4.5 minutes, as reflected in newly added Claim 13.

Herron, directed to the use of "fiber slurries," further fails to teach or suggest advantageous methods in which the cellulose ether is moistened with 10 to 80 % water, based on

the amount of cellulose ether, or suspended in 30 to 60% organic suspension medium, based on the amount of cellulose ether, as recited in Claim 11.

Nor does Herron, expressly teaching a double de-watering process prior to crosslinking, teach or suggest the advantageous methods of Claim 14, in which a single drying step performed directly on a milled cellulose ether composition forms an ester bond or hemiacetal bond. Applicants further respectfully submit that there would have been no motivation for Herron to have avoided his double de-watering steps, particularly in light of Menkart's express teaching of filtration prior to drying.

Herron, expressly teaching aqueous slurries and a cross-linking temperature of 145 °C, similarly fails to teach or suggest methods comprising initially admixing a cellulose ether composition in an organic suspension medium, much less such methods in which the acid groups and aldehyde groups of the chemical compounds are reacted at a temperature ranging from 50 to 105 °C, as recited in newly added Claim 15. Applicants likewise respectfully submit that there would have been no motivation for Herron to have incorporated such organic suspension medium and moderate reaction temperatures.

Accordingly, Applicants respectfully submit that the claimed invention cannot be rendered obvious in light of Herron, considered either alone or in combination with the remaining art of record.

Applicants further respectfully submit that there would have been no motivation to have combined Menkart and Herron. Menkart is directed to the conventional use of glyoxal to promote dispersibility. Herron is directed to permanently crosslinked fibers used in absorbent pads. Applicants respectfully reiterate that these are altogether different fields of endeavor and problems solved.

However, even if Applicants had combined Menkart and Herron (which they did not do), the claimed invention would not have resulted.

Particularly, the combination of references does not teach or suggest the inventive methods for producing cross-linked cellulose ethers in which cellulose ethers are admixed with chemical compounds containing at least one aldehyde group and at least one acid group and the acid groups of the chemical compounds are then reacted with the OH groups of the cellulose ethers to form an ester bond. Applicants respectfully submit that the outstanding Office Action's urgings on Page 5, first full paragraph concerning the expectation of success in the use of chemical compounds containing at least one aldehyde group and at least one acid group with the recited cellulose ether (which is well known in the art to provide fewer and less reactive hydroxyl groups, as noted above) are pure conjecture. Applicants respectfully submit that there would instead have been no expectation of success by one skilled in the art, as discussed above.

And the combination, altogether silent as to solvation delay, most certainly does not teach or suggest that cellulose ether containing from 0.01 to 0.1 mol per mole of a chemical compound containing at least one aldehyde group and at least one acid group would result in reversibly-crosslinked cellulose ether having a solvation delay of a few seconds to a plurality of hours, as recited in Claim 1 as-amended.

Thus the combination can not teach or suggest that cellulose ether containing from 0.01 to 0.1 mol per mole of a chemical compound containing at least one aldehyde group and at least one acid group would result in reversibly-crosslinked cellulose ether having a solvation delay of at least 4.5 minutes, as reflected in newly added Claim 13.

The combination further fails to teach or suggest advantageous methods in which the cellulose ether is moistened with 10 to 80 % water, based on the amount of cellulose ether, or suspended in 30 to 60% organic suspension medium, based on the amount of cellulose ether, as

recited in Claim 11. The primary reference instead expressly teaches admixing a dilute solution, and the secondary reference generically discloses a "slurry" of unspecified concentration.

And the combination, expressly teaching the removal of water from the cellulose ether prior to crosslinking, does not teach or suggest the direct drying of a milled cellulose ether composition to form an ester bond or hemiacetal bond, as recited in newly added Claim 14.

The combination likewise fails to teach or suggest advantageous methods incorporating an organic suspension medium, separate drying and crosslinking steps, and crosslinking performed at moderate temperatures, as recited in newly added Claim 15.

Accordingly, Applicants respectfully submit that the claimed invention is patentable in light Menkart and Herron, considered either alone or in combination.

CONCLUSION

It is respectfully submitted that Applicants have made a significant and important contribution to the art, which is neither disclosed nor suggested in the art. It is believed that all of pending Claims 1, 3, 4, 6 through 9 and 11 through 15 are now in condition for immediate allowance. It is requested that the Examiner telephone the undersigned if any questions remain to expedite examination of this application.

It is not believed that extensions of time or fees are required, beyond those which may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time and/or fees are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required is hereby authorized to be charged to Deposit Account No. 50-2193.

Respectfully submitted,



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